

# **Method of Fabricating a Magnetic Transducer with Multilayer Conductive Leads Including a Tantalum Layer, a Chromium Layer and a Rhodium Layer**

## **5    Related Application**

This is a divisional of application 09/728,731 filed on 11/30/2000.

## **Field of the Invention**

10

The invention relates to the field of magnetic transducers (heads) and more particularly to methods, materials and structures used to form conductive leads in the heads.

15

## **Background of the Invention**

20

25

30

A typical prior art head and disk system is illustrated in figure 1. In operation the head 10 is supported by the suspension 13 as it flies above the disk 16. The magnetic transducer, usually called a "head," is composed of elements that perform the task of writing magnetic transitions (the write head 23) and reading the magnetic transitions (the read head 12). The electrical signals to and from the read and write heads 12, 23 travel along conductive paths (leads) 14 which are attached to or embedded in the suspension 13. Typically there are two electrical contact pads (not shown) each for the read and write heads 12, 23. Wires or leads 14 are connected to these pads and routed in the suspension 13 to the arm electronics (not shown). The disk 16 is attached to a spindle 18 that is driven by a spindle motor 24 to rotate the disk 16. The disk 16 comprises a substrate 26 on which a plurality of thin films 21 are deposited. The thin films 21 include ferromagnetic material in which the write head 23 records the magnetic transitions in which information is encoded.

There are several types of read heads 12 including Giant  
Magnetoresistive (GMR) and tunnel junction. It is important for the two leads  
(not shown) that provide the electrical connection to the sensor element (not  
shown) in a magnetoresistive head 12 to be of low resistance, to be consistently  
5 manufacturable and to be resistant to formation of shorts during the  
manufacturing process. Typically leads (not shown) have been made from  
copper, tungsten, tantalum or gold, but the requirements of heads like spin  
valves make these traditional simple leads inadequate. To meet the new  
requirements, leads with a multilayer structure have been proposed. For  
10 example, US patent 5,438,470 to Ravipati, et al., suggest using a thin layer of  
tantalum under a layer of gold for the leads. Ravipati '470 also teaches that lower  
resistance leads are obtained by placing the leads in contact with the hard bias  
layer as well the magnetoresistive sensor. US patent 5,491,600 to Chen, et al.,  
describes leads with two refractory metal layers sandwiching a highly conductive  
15 metal layer. One embodiment is alternating layers of tantalum and gold. In the  
particular type of head described in Chen '600, the leads from the spin valve  
sensor layer stack are formed on material used for the hard bias, e.g., CoPtCr.  
The CoPtCr layer in turn has a Cr underlayer.

US patent 5,883,764 to Pinarbasi similarly describes a multilayer lead  
20 structure, for example, 3.5 nm Ta, 3.5 nm Cr and 75 nm Ta. The hard bias layer  
is again CoPtCr.

The substrate on which hard bias layers are formed in some head designs  
is NiO or alumina. Rhodium has been used as a lead material for these heads.  
Other designs use PtMn as the substrate for the hard bias layer on which the  
25 leads must be formed. However, the resistance of rhodium leads is  
unacceptably increased when the hard bias and lead stack are formed on a PtMn  
substrate.

## Summary of the Invention

A head according to the invention includes multilayered electrically conductive leads from the magnetic sensor which include a thin tantalum seed layer followed by a thin chromium seed layer which is followed by a thicker rhodium layer. The dual seed layer of the invention significantly improves the conductivity of the rhodium. The Ta/Cr/Rh leads can be used with hard bias structures formed on a PtMn layer without having increased resistance.

## Brief Description of the Figures

Figure 1 is an illustration of the prior art showing the relationships between the head and associated components in a disk drive.

Figure 2 is an illustration of a section, parallel to the air bearing surface, of a head with the multilayered leads according to the invention overlaid on the hard bias structures and the upper surface of the magnetic sensor.

Figure 3 is an illustration of a section, parallel to the air bearing surface, of a head with the multilayered leads according to the invention formed on the hard bias structures which are formed on a layer of PtMn and with the leads in electrical contact with the magnetic sensor through the hard bias structures.

Figure 4 is an illustration of a section, parallel to the air bearing surface, of a head with the multilayered leads according to the invention formed on the hard bias structures and where the layer of PtMn has been etched away completely from the surface of the gap layer except the area underneath the spin valve.

## Detailed Description of the Invention and the Preferred Embodiments

A first embodiment of the invention in a spin valve head 12A is illustrated in figure 2 in a section view taken parallel to the air bearing surface (not shown).

5 The improved conductivity which results from the multilayered lead structure 36A, 36B of the invention can be used in other embodiments as will be clear to those skilled in the art. The relative thickness of the layers are not according to scale to allow the layers to be seen more clearly. The thickness of each layer is according to the prior art with the exceptions noted below. Gap layer 31  
10 underlies the two hard bias structures 33A, 33B. The hard bias structures 33A, 33B are shown as a single element even though they include more than one layer, e.g., a chromium layer (not shown) followed by a CoPtCr layer (not shown). The spin valve 35 is likewise illustrated as a single entity for simplicity even though it includes several layers.

15 In this embodiment the multilayered leads 36A, 36B are of the so-called overlaid type in that they are deposited in contact with the top surface of the spin valve 35 and the hard bias structures 33A, 33B. The multilayered leads 36A, 36B include the thin tantalum layer 37 which is used as a seed layer deposited directly onto the exposed ends of the top surface the spin valve 35 and the hard  
20 bias structures 33A, 33B. As in the prior art the central area of the spin valve 35 will be covered with a protective material such as photoresist (not shown) which is subsequently lifted off. The tantalum layer 37 is deposited by a thin film deposition technique such as sputtering or ion beam deposition. This layer can be very thin, e.g., approximately 3.5 nm, but can also be several times as thick  
25 and still perform its function. As with other thin film seed layers, the role of the tantalum layer 37 is to affect the grain size and the crystal orientations of the subsequent layer(s). The next layer after the tantalum layer 37 is a thin film layer of chromium 38. The chromium layer 38 thickness is on the order the tantalum layer 37 and in effect serves as a second seed layer. The chromium  
30 layer 38 is also deposited by a thin film deposition technique such as sputtering or ion beam deposition.

The chromium layer 38 is followed by a much thicker layer of rhodium 39. As mentioned above the relative thickness of the layers as shown on figure 2 is not according to scale. The rhodium layer 39 is preferably much thicker than the seed layers, e.g., more than ten times thicker. A thickness of 75 nm is a reasonable value. The values of the thickness of the layers of the leads 36A, 36B according to the invention are not critical. The tantalum and chromium layers 37, 38 need only be thick enough to properly establish the growth conditions for the rhodium film 39. The rhodium film 39 needs to be thick enough to provide the conductance needed for the particular magnetic sensor being used.

Figure 3 is a section parallel to the ABS (not shown) similar to figure 2, but the spin valve head 12B illustrated has a so-called semi-contiguous junction (not shown). In this embodiment the hard bias layers 33A, 33B are deposited on a layer of PtMn 41 which is deposited on the gap layer 31. The hard bias layers 33A, 33B do not extend over the entire lateral surfaces of the spin valve 35. The multilayered leads 40A, 40B according to the invention are deposited on top of the hard bias structures 33A, 33B as in the prior art and make electrical contact with the sensor 35 through the hard bias structures 33A, 33B. In contrast to the overlaid leads 36A, 36B of figure 2, the leads 40A, 40B in this embodiment do not extend above the spin valve 35.

Figure 4 illustrates an alternative type of spin valve head 12C in which the multilayered leads 40A, 40B according to the invention can be used. Figure 4 is a section of a spin valve head 12C similar to that of figure 3, but in this head the PtMn layer 41 is etched away completely from the surface of the gap layer 31 except the area underneath the spin valve 35.

As noted above Cr/CoPtCr is used in some prior art heads for the hard bias layers 33A, 33B. In experiments using a Cr/CoPtCr hard bias layer and a 75 nm rhodium conductive layer with varying seed layers, the resistance measurements in ohms/cm<sup>2</sup> shown in Table 1 were obtained on bare glass substrates and on glass with 20 nm of PtMn.

---

Table 1

	Seed(s)	Glass	PtMn (20nm)
5	None	1.12	1.23
	Cr	1.11	1.25
	Ta	1.19	1.2
	Ta/Cr	1.04	1.05

---

10

Each seed layer in the experiment was 3.5 nm thick. These values were obtained after 232 C annealing. Neither the Cr seed layer nor the Ta seed significantly affected the resistance in the PtMn case. The dual seed layer of Ta/Cr reduced the resistance by approximately 15%.

15

It is to be expected that the addition of small amounts of other elements to either the Ta seed layer 37 or the Cr seed layer 38 would produce results that are consistent with those obtained from the pure elements. For example, in the prior art small amounts of vanadium and titanium have successfully been added to thin film chromium underlayers without disrupting the bcc structure. The effect

20

is to modulate the lattice constant. It also follows that the tantalum and chromium seed layers 37, 38 deposited by standard thin film techniques may have a certain amount of contamination and still serve their intended purpose.

25

Although the embodiments of the invention have been described in a spin valve head environment, the multilayer leads as described herein are not limited to this application. Those skilled in the art will recognize that the multilayered leads of the invention may be used in other magnetic transducer types such as tunnel junctions.

30